HISTORIC CITY OF FRANKLIN

BEST MANAGEMENT PRACTICES STORMWATER MANAGEMENT MANUAL

Prepared for
City of Franklin Engineering Department

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CITY OF FRANKLIN
ENGINEERING DEPARTMENT
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Introduction

1.1 Background and Purpose

Development typically increases the amount of hard surface on a site which affects the flow of water as it rains by increasing the volume and rate of stormwater runoff. If not managed, increased peak flows and volumes could result in flooding and channel erosion. In addition, typical stormwater runoff from urban sites contains pollutants such as litter, sediment, oils and greases, nutrients and metals, bacteria, fertilizers, and debris. These pollutants are carried into streams and other water bodies through the stormwater drainage system. Urbanized areas, including the City of Franklin, are required under Federal and State law, through the National Pollutant Discharge Elimination System (NPDES) Phase II requirements, to reduce the discharge of these stormwater pollutants and achieve stormwater treatment goals set by the U.S. Environmental Protection Agency. New developments and significant redevelopments in Franklin are therefore required to design, install, and maintain stormwater quantity controls in addition to stormwater quality controls.

This manual of Best Management Practices (BMPs) has been compiled for the City of Franklin to assist contractors, developers, and various businesses and industries to comply with the guidelines set forth by the National Pollution Discharge Elimination System (NPDES) Phase II Rule. This manual will assist the City of Franklin by requiring use of practices that benefit water quality, an overall goal of the Phase II program. Specifically this manual will assist in stormwater pollution prevention through impact-reducing site design, BMP selection, construction management, post-construction management, and good housekeeping measures.

The manual focuses on impact-reducing site design, erosion prevention and sediment control (EPSC) measures used during construction, permanent (post-construction) structures used to manage the quantity and quality of stormwater runoff created by an increase in impervious areas, and good-housekeeping measures to assist commercial and industrial facilities whose business practices may affect stormwater quality.

The fact sheets in this manual are designed for easy reference. They are categorized, focused, and concise to allow easy access and expedient use. Each fact sheet can be used as a stand-alone document that may be distributed to facilitate focused discussion about design and/or implementation of each management practice. However, the goals of Franklin's stormwater management program will not be met by simply installing BMPs. This document is intended to guide the design of a project from start to finish and stormwater management should be part of the site design considerations in the initial phase of conceptual design. There are BMPs that require structural practices while many are non-structural practices where everyday activities may be performed in a manner that limits the impact of stormwater runoff to surface water quality.

INSERT SECTIONS 1.2 THRU 1.4 HERE

1.5 Post Construction Water Quality Policies and Procedures

Performance requirements and minimum standards for controlling runoff from development are critical to addressing both the water quantity and quality impacts of post-construction urban stormwater and are a required component of Franklin's NPDES Phase II permit. The overall goal of the City's stormwater program is to reduce the adverse impacts of urban development on the area's natural stream system and adjacent property owners, and to do so in a manner that takes maximum advantage of natural processes and designs.

Therefore, the City of Franklin has established a permanent practice stormwater quality program that applies a reasonable and consistent standard for pollutant removal and quantity control. In addition, the City has developed a design approach for meeting this standard that encourages design of stormwater quality and quantity controls early in the design process. These standards are set forth in the City of Franklin's Stormwater Management Ordinance.

The City of Franklin has adopted a four-step Integrated Site Design (ISD) process in the consideration of stormwater design. These steps fit well into the general process of land development and serve to assist the designer in making maximum use of the natural features of the site to treat and handle stormwater runoff in a way that integrates such practices into the site layout. The four-step process is:

Step 1. Impact-Reducing Site Design - The first step in addressing stormwater management begins with the site planning and design process. The goal of better site design is to reduce the amount of runoff and pollutants that are generated from a development site and provide for some nonstructural on-site treatment and control of runoff by implementing a combination of approaches which are impact reducing (green) site design practices. These include maximizing the protection of natural features and resources, developing a site design that minimizes impact, reducing overall site imperviousness and utilizing natural systems for stormwater management.

Step 2. Integrated Stormwater Sizing Criteria – This is an integrated set of design criteria for stormwater quality and quantity management which addresses the entire range of hydrologic events. These criteria allow the site engineer to calculate the stormwater control volumes required for water quality, and flood protection.

Step 3. Stormwater Credits for Impact Reducing Design – A set of stormwater "credits" can be used to provide developers and site designers an incentive to implement impact reducing (green) design practices that can reduce the volume of stormwater runoff and minimize the pollutant loads from a site. The credit system directly translates into cost savings to the developer by reducing the required water quality treatment volume, therefore reducing the size of structural stormwater control and conveyance facilities.

Step 4. Selection of Structural Stormwater Controls – Available in this manual are a wide variety of structural stormwater controls that can be used to fully or partially meet stormwater management water quantity and quality goals. For water quality, the pollutant removal target for Franklin is a 90% reduction of total suspended solids (TSS) with a requirement of at least 80%.

1.5.1 Pollutant Reduction Goal

Once construction has been completed on a development site and the site has been stabilized, pollutants can be washed off of hardened or impervious surfaces, such as driveways, roads, and roofs, through the storm drain system and into receiving streams. Stormwater runoff from stabilized urban sites typically contains pollutants such as litter, sediment, oils and greases, nutrients and metals, bacteria, fertilizers, and debris. These pollutants are carried into receiving water bodies through the stormwater drainage system. Stormwater pollutants can have very negative effects on water bodies, such as increasing turbidity, increasing temperatures, degrading habitat, recreation and aesthetic losses, contaminant transport, and channel and bank erosion. They can also impair the growth, reproduction, and survival of aquatic life.

In order to meet the NPDES requirements of removing stormwater pollutants to the "maximum extent practicable" or MEP, Franklin has adopted a pollutant removal performance goal based on percentages. This is an agreed to set of programs and criteria established by the state. By authorization given in the Ordinance, stormwater management systems for new development and redevelopment must be designed to remove at least 80% of the average annual post-construction total suspended solids (TSS) load. This performance goal is based upon U.S. Environmental Protection Agency (EPA) guidance and has been adopted by many local and statewide agencies.

TSS was chosen as the representative stormwater pollutant for measuring treatment effectiveness for several reasons:

1. Sediment, as well as other pollutants of concern that adhere to suspended solids, are a major source of water quality impairment due to urban development in Tennessee watersheds.

2. Siltation is the leading cause of degradation of aquatic life habitat in Tennessee.
3. Many other pollutants of concern are either removed along with TSS, or at rates proportional to the TSS removal.
4. The 80% TSS removal level is reasonably attainable using well-designed structural stormwater controls (for typical ranges of TSS concentration found in stormwater runoff).
5. The use of TSS as an "indicator" for many other stormwater pollutants is well established.

Developments must attempt to meet the 90% TSS reduction goal and must meet the 80% TSS reduction requirement for the entire project site through use of structural best management practices (BMPs) as described in Section 1.5.5. A site might be divided into several drainage areas, with each drainage area receiving treatment from a different BMP or non-structural method. While each drainage area does not have to achieve an 80% TSS reduction on its own, the weighted averages of TSS reduction from those areas must be equal to or greater than an 80% TSS reduction. It is presumed that a stormwater management system complies with this performance standard if:

- It is sized to capture and treat the water quality treatment volume (WQv), which is defined as the **runoff** volume resulting from the first 1.1 inches of rainfall from a site (and is further described in Section 1.5.3); and
- Appropriate structural stormwater controls are selected, designed, constructed, and maintained according to the specific criteria in this Manual.

The City of Franklin reserves the right to require other treatment goals for other pollutants of concern based on other regulatory requirements or needs (e.g. Total Maximum Daily Load studies).

1.5.2 Step 1 – Lay Out Site Using Impact-Reducing Site Design

The first step in addressing stormwater management begins with the site planning and design process. Impact-reducing site design for stormwater management includes a number of site design techniques such as preserving natural features and resources, effectively laying out the site elements to reduce impact to the watershed, reducing the amount of impervious surfaces, and utilizing natural features on the site for stormwater management. The goal is to minimize impacts of development by reducing the amount of runoff and pollutants that are generated from a development or redevelopment site, and provide for some nonstructural on-site treatment and control of runoff.

Impact-reducing site design concepts can be viewed as both water quantity and water quality management tools that can reduce the size and cost of required structural stormwater controls – sometimes eliminating the need for them entirely – while maintaining or even increasing the value of the property. This site design approach can result in a more natural and cost-effective stormwater management system that better mimics the natural hydrologic conditions of the site, has a lower maintenance burden and increases sustainability.

The steps below describe key impact-reducing site design practices and techniques recommended in this Manual. Figures 1.5-3 and 1.5-4 illustrate the use of some of these impact-reducing site design principles for a residential and commercial example, respectively.

Step 1: Identify Natural Features and Resources

The first step in the impact-reducing site design process is to identify and preserve the natural features and resources that can be used in the protection of water resources by reducing stormwater runoff, providing runoff storage, reducing flooding, preventing soil erosion, promoting infiltration, and removing stormwater pollutants. The design engineer should collect and review information on the existing site conditions and map site features such as:

- Areas of undisturbed vegetation
- Floodplains and riparian areas
- Ridgetops and steep slopes
- Natural drainage pathways
- Intermittent and perennial streams
- Aquifers and recharge areas
- Wetlands
- Soil types
- Other natural features or critical areas

Other features that should be identified in this step are adjacent areas, existing developed areas, and existing stormwater facilities and infrastructure.

Step 2: Delineate and Preserve Natural Features

Delineation of natural features is typically done through a comprehensive site analysis and inventory before any site layout design is performed and correlates with many of the current Franklin zoning requirements. Approaches that should be followed in conserving natural features and resources include the desire to:

- Preserve undisturbed natural areas
- Preserve stream buffers
- Avoid floodplains
- Avoid steep slopes
- Minimize development on porous or erodible soils
- Use lower impact site design techniques

Preservation of natural areas and stream buffers can be used as a credit (see Section 1.5.4) to reduce the required water quality treatment volume.

Step 3: Design to Reduce Runoff Impacts
After conservation areas have been delineated, there are additional opportunities in the preliminary stages of a site design for avoiding downstream stormwater impacts from the development.

These primarily deal with the location and configuration of lots or structures on the site and include the following recommendations and options:

- Fit the design to the terrain
- Reduce the limits of clearing and grading (i.e., limit clearing and grading areas to what is absolutely necessary)
- Locate development in less sensitive areas (e.g., outside of wetlands)
- Utilize open space
- Use nontraditional lot designs for residential areas (think outside the box)
- Consider creative development design

Step 4: Reduce and Disconnect Impervious Cover
Reducing the area of total impervious surface on a site directly reduces the volume of stormwater runoff and associated pollutants that are generated, while also reducing the size and cost of necessary infrastructure. Some of the methods to reduce impervious include:

- Reduce roadway widths and lengths
- Reduce the footprint of buildings (consider building up instead of out)
- Reduce the parking footprint and consider pervious pavement
- Reduce setbacks and frontages
- Use fewer or alternative cul-de-sacs (and grass the center of cul-de-sacs)
- Disconnect impervious areas
- Utilize infiltration as much as possible

Step 5: Utilize Natural Features for Stormwater Management
Traditional stormwater drainage design tends to ignore and replace natural drainage patterns and often results in overly efficient hydraulic conveyance systems. Structural stormwater controls are costly and often can require high levels of maintenance for optimal operation. Through use of natural site features and drainage systems, careful site design can reduce the need and size of structural conveyance systems and controls. Some of the methods of incorporating natural features into an overall stormwater management site plan include the following:

- Preserve buffers and undisturbed areas
- Use natural drainage paths instead of storm sewer infrastructure
- Use vegetated swales instead of curb and gutter
- Drain runoff to pervious areas

Review Section 1.4.2 of Volume 2 of the Georgia Stormwater Management Manual for more guidance on impact-reducing site design practices.

1.5.3 *Step 2 - Design Using Integrated Stormwater Sizing Criteria*

This section presents an integrated sizing approach for meeting the City's stormwater runoff **quality and quantity** management requirements found in the Ordinance, by addressing the key adverse impacts of stormwater runoff from a development site. The purpose is to provide a framework for designing (sizing) a stormwater management system to:

- Remove stormwater runoff pollutants and improve water quality;
- Reduce downstream overbank flooding; and
- Safely pass or reduce the runoff from extreme storm events.

The *Integrated Stormwater Sizing Criteria* is an integrated set of criteria or design standards that allow the site engineer to size and design structural stormwater controls to address all of these objectives. There are four criteria, one for each of the goals above, which are summarized in Table 1.5-1 below.

Table 1.5-1 Summary of Sizing Criteria for Stormwater Control and Mitigation

Sizing Criteria	Description
Water Quality	Treat the runoff from 85% of the storms that are expected to occur in any year. For Franklin, this equates to providing water quality treatment for the **runoff** resulting from a rainfall depth of 1.1 inches. Treating involves reducing average annual post-development total suspended solids loadings by the pollutant removal goal of 90% and requirement of 80%.
Overbank Flood Protection	Provide peak discharge control of the 2, 10, 25, and 50-year storm event such that the post-development peak discharge rate does not exceed the predevelopment discharge rate to reduce overbank flooding.
Extreme Flood Protection	Evaluate the effects of the 100-year storm on the stormwater management system, adjacent property, and downstream facilities and property. Manage the impacts of the extreme storm event through detention controls and/or floodplain management.

Each of the integrated stormwater sizing criteria are intended to be used with one another to address the overall stormwater impacts from a development site. When used as a comprehensive set, the integrated criteria control the entire range of hydrologic events, from the smallest runoff-producing rainfalls to the 100-year storm. Figure 1.5-1 graphically illustrates the relative volume requirements of each of the integrated stormwater sizing criteria and demonstrates that the criteria are generally "nested" within one another, (i.e., the extreme flood protection volume requirement also contains the overbank flood protection volume and the water quality treatment volume). This nesting provides efficiency when constructing and maintaining stormwater controls.

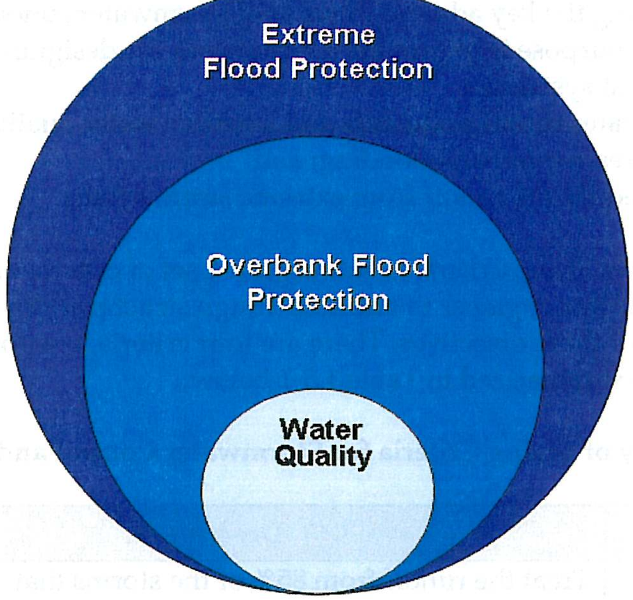


Figure 1.5-1 Representation of the Integrated Stormwater Sizing Criteria

The following sections describe each of the four integrated stormwater sizing criteria in more detail.

<u>**Water Quality (WQ_v)**</u>

Hydrologic studies show that small-sized, frequently occurring storms account for the majority of rainfall events that generate stormwater runoff. Consequently, the runoff from these storms also accounts for a large portion of the annual pollutant loadings. Therefore, by treating these frequently occurring smaller rainfall events and a portion of the stormwater runoff from larger events, it is possible to effectively mitigate the water quality impacts from a developed area.

A water quality treatment volume (WQ_v) (a rainfall depth, P, modified by a runoff coefficient, R_v, and sized for an area, A) is specified to size structural control facilities to treat these small storms up to a maximum runoff depth and the "first flush" of all larger storm events. The maximum depth is specified to be the runoff generated from the 85th percentile storm event (i.e., the storm event depth that is greater than 85% of the storm depths that are expected to occur within any one year). The 85th percentile volume was considered the point of optimization between pollutant removal ability and cost-effectiveness. In other words, capturing and treating a larger percentage of the annual stormwater runoff would provide only a small increase in additional pollutant removal, but would considerably increase the required size (and cost) of the structural stormwater controls.

Based on a rainfall analysis for middle Tennessee this depth is 1.1 inches. Therefore, a stormwater management system designed for the WQ_v will treat the runoff from all storm events of 1.1 inches or less, as well as the first 1.1 inches of runoff for all larger storm events. The relevant equations are:

$$WQ_v = \frac{PR_vA}{12} \qquad \textbf{(Equation 1)}$$

$$R_v = 0.015 + 0.0092I \qquad \textbf{(Equation 2)}$$

where:

	WQ_v	= water quality treatment volume (acre-feet)
	P	= rainfall depth for the 85% storm event (1.1 inches)
	R_v	= runoff coefficient (see Equation 2)
	A	= drainage area (acres)
	I	= percent of impervious cover in drainage area - 50% would be 50 not 0.50

The WQ_v is directly related to the percent of impervious cover. It is equivalent to a rainfall depth of 1.1 inches multiplied by the volumetric runoff coefficient (R_v). Multiplication by the site area and division by 12 converts the inch value to acre-feet. Figure 1.5-2 shows the water quality depth versus impervious percentage. The water quality depth required for treatment can be found along the line in the figure if the percent impervious is known. This depth can then be multiplied by the area divided by twelve to calculate the required water quality volume (WQ_v).

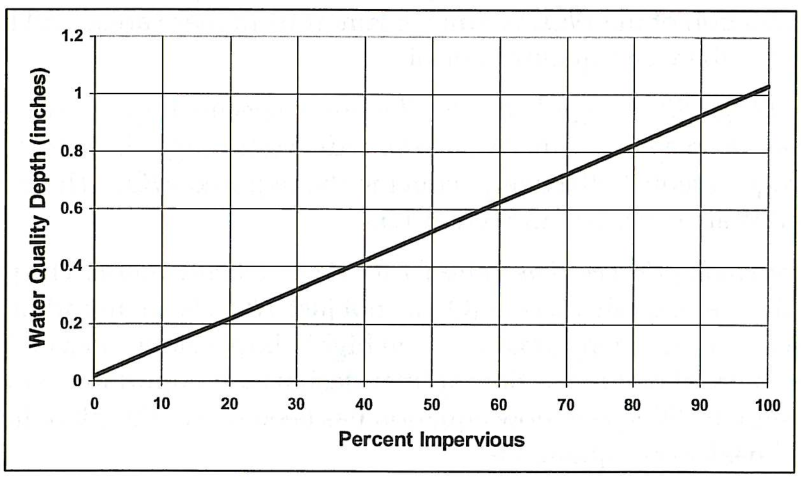


Figure 1.5-2 Water Quality Depth versus Percent Imperviousness

This water quality treatment volume supersedes all other water quality design volume requirements contained in technical guidance documents and shall be used for all permanent treatment structures. Guidance that specifically includes this WQ_v approach can be found at http://www.nashville.gov/stormwater/regs/index.htm .

Treatment of the WQ_v to remove 80% of TSS is required for all new development and redevelopment. The City of Franklin reserves the right to require other treatment goals for other pollutants of concern based on other regulatory requirements or needs (e.g. Total Maximum Daily Load studies).

Determining the Water Quality Volume (WQ_v)

- *Measuring Area of Development*: The area A in Equation 1 includes the entire development site except as modified by Site Design Credits (see below and Section 1.5.4). It does not include areas outside of the development site. All calculations related to WQ_v (but not CP_v or Q) are based on the conditions of the developed site, not off-site areas.
- *Measuring Impervious Area*: The area of impervious cover can be taken directly off a set of plans or appropriate mapping. I is expressed as a percent value in Equation 2, not a fraction (e.g., I = 30 for 30% impervious cover). Impervious areas include but are not limited to the following: roads, streets, driveways, sidewalks, and building footprints which include exposed foundations, roofs, porches, patios, and decks. Of course, in cases where these structures (i.e., sidewalks, driveways, and roads) are constructed using approved pervious materials, they would not be included in the impervious area calculation.
- *Multiple Drainage Areas*: When a development project contains or is divided into multiple drainage areas, WQ_v should be calculated and addressed separately for each drainage area.
- *Off-site Drainage Areas:* The objective is to treat your own site's runoff and bypass off site runoff in such a way that it does not interfere in your own treatment. Off-site existing impervious areas may be excluded from the calculation of the WQ_v volume, if runoff from these areas will be designed to bypass the water quality control.
- *Credits for Site Design Practices*: The use of specific impact-reducing site design practices may allow the WQ_v to be reduced through the subtraction of a site design "credit," effectively reducing the required WQ_v. These site design credits are described in Section 1.5.4.
- *Determining the Peak Discharge for the Water Quality Storm:* The peak discharge of the water quality storm (Q_{wqp}), not just WQ_v, is an important design parameter for many smaller, often highly impervious, areas where smaller commercial devices or flow splitter designs are important. To simplify this design the SCS peak flow equation has been used with place holders. The SCS peak flow equation is:

$$Q_{wqp} = \frac{q_u A WQ_{vi}}{640} \qquad \textbf{(Equation 3)}$$

where: Q_{wqp} = water quality peak flow (cfs)
q_u = peak unit discharge in cfs/inch of rain/sq mile of drainage
WQ_{vi} = water quality treatment depth (inches) = PR_v
A = drainage area (acres)

- For a smaller (less than 3 acres) 100 percent impervious area where q_u can be taken as 1000 this reduces to a simplified single number. The runoff peak for the water quality storm is **1.6 cfs per acre**. This number should be used unless the designer feels it is inappropriate, in which case equation 3 should be used.

Overbank Flood Protection (Qp)

An increase in impervious areas by development increases the potential for downstream flooding. The purpose of overbank flood protection is to prevent an increase in the frequency and magnitude of damaging out-of-bank flooding (i.e. flow events that exceed the capacity of the channel and enter the floodplain). It is intended to protect downstream properties from flooding at middle-frequency storm events.

The Overbank Flood Protection criterion specifies that the post-development 2, 10, 25, and 50-year, 24-hour storm peak discharge rate (denoted *Qp*) not exceed the pre-development (or undisturbed natural conditions) discharge rate.

Also note that application of nonstructural site design practices that encourage infiltration and reduce the total amount of runoff will also reduce the overbank flood protection volume by a proportional amount.

Determining the Overbank Flood Protection Volume (Qp)

- *Peak-Discharge and Hydrograph Generation:* The SCS hydrograph method provided can be used to compute the peak discharge rate and runoff for the various storms.
- *Rainfall Depths:* The rainfall depths of the design storms in the City of Franklin can be found in the *TDOT Design Division Drainage Manual, 2006.* http://www.tdot.state.tn.us/Chief_Engineer/assistant_engineer_design/design/DrainManpdf/Chapter%204.pdf as taken from NOAA Atlas 14 Shelbyville Station (40-8246) 35.4917 N 86.475 W

2-year storm	3.87 inches
10-year storm	5.38 inches
25-year storm	6.29 inches
50-year storm	7.01 inches

- *Design Analysis:* Analysis shall use criteria and standards as provided in the latest City of Franklin Stormwater Management Ordinance.

<u>Extreme Flood Protection (Q_f)</u>

The intent of the extreme flood protection is to prevent flood damage from infrequent but large storm events, maintain the boundaries of the mapped 100-year floodplain, and protect the physical integrity of the structural stormwater controls as well as downstream stormwater and flood control facilities.

The Extreme Flood Protection criterion specifies that all stormwater management facilities be designed to control runoff for the 100-year, 24 hour storm (denoted Q_f) so that the rate at which flow is released over the entire runoff discharge period is equal to or less than predevelopment flows.

It is recommended that stormwater systems be designed such that Q_f be routed through the drainage system and stormwater management facilities to determine the effects on the facilities, adjacent property, and downstream areas. Emergency spillways of structural controls should be designed appropriately to safely pass the resulting flows.

Determining the Extreme Flood Protection Criteria (Q_f)

- *Peak-Discharge and Hydrograph Generation:* The SCS unit hydrograph method can be used to compute the peak discharge rate and runoff for the 100-year, 24-hour storm.
- *Rainfall Depths:* The rainfall depth of the 100-year, 24-hour storm for the City of Franklin is 7.75 inches (*TDOT Design Division Drainage Manual, 2006*).
- *Off-site Drainage Areas:* Runoff from off-site drainage areas should be included in calculations.
- *Downstream Analysis:* If Q_f is considered for waiver downstream areas should be checked through hydrologic modeling of the design storms to ensure there is no peak flow increase above pre-development conditions to the point where the site area is 10% of the total drainage to that point.

1.5.4 Step 3 – Stormwater Site Design Credits

It is the City of Franklin's goal to reduce the impact of development upon stormwater quantity and quality. Therefore, stormwater "credits" have been developed as incentives to implement practices that can reduce the volume of stormwater runoff and minimize the pollutant loads from a site. The basic premise of the credit system is to recognize the water quality benefits of certain impact-reducing site design practices (sometimes called Low Impact Design, Green Design or Better Site Design) by allowing for a reduction in the water quality treatment volume (WQ_v). Incorporating one or more of the credited practices in the design of the site will reduce the water quality volume required to be captured and treated.

Therefore, the credit system directly translates into cost savings to the developer by reducing the size of structural stormwater control and conveyance facilities.

The impact-reducing site design practices that provide stormwater credits are listed in Table 1.5-2 and are further described in the sections below. The developer should consider these practices early in the design process in an effort to reduce the overall water quality treatment volume requirement. Site specific conditions will determine the applicability of each credit. For example, stream buffer credits cannot be taken on upland sites that do not contain perennial or intermittent streams.

It should be noted that impact-reducing site design practices and techniques that reduce the overall impervious area on a site but do not involve handling runoff already implicitly reduce the total amount of stormwater runoff generated by a site (and thus reduce WQ_v) and are not further credited under this system.

Table 1.5-2 Impact-Reducing Site Design Practices That Provide For Site Design Credits

Practice	Description
Natural Area Conservation	Undisturbed natural areas and waterway buffers are conserved and protected through legal instrument, thereby retaining their pre-development hydrologic and water quality characteristics.
Drains to Buffer	Stormwater runoff is treated by directing sheet flow runoff through a naturally vegetated or forested buffer as overland flow.
Vegetated Channels	Grass channels are used to provide stormwater treatment and conveyance rather than hard structure systems such as pipe and curb and gutter.
Overland Flow Filtration/Infiltration Zones	Overland flow filtration/infiltration zones are incorporated into the site design to receive runoff from rooftops and other small impervious areas.
LID Large Lot Subdivisions	A group of Low Impact Design (LID) techniques are applied to low and very low density residential development.

To have an area approved as a credit, all criteria specified by the credit must be met. The intent of the suggested design conditions (e.g., flow length, contributing area, etc.) is to avoid situations that could lead to a credit being granted without the corresponding reduction in pollution attributable to an effective site design modification.

Site designers are encouraged to utilize as many credits as they can on a site. Greater reductions in stormwater storage volumes can be achieved when many credits are combined (e.g., disconnect rooftops and use vegetated channels). However, credits cannot be claimed twice for an identical area of the site (e.g. claiming credit for stream buffers and disconnecting rooftops over the same site area).

Site Design Credit #1: Natural Area Conservation

This credit may be given when undisturbed natural areas are conserved and protected through legal instrument, thereby retaining their pre-development hydrologic and water quality characteristics. Under this credit, the conservation area should be subtracted from total site area (A in Equation 1) when computing water quality volume requirements. An added benefit is that the post development peak discharges will be smaller, and hence water quantity control volumes (Qp, and Q_f) will be reduced due to lower post-development curve numbers or rational formula "C" values.

To receive credit:

- Conservation area cannot be disturbed during project construction. If prior to development the area is not acceptable as a natural area, the area can be restored as a natural area with a suitable planting and management plan in place.
- The limits of disturbance around the conservation area must be clearly shown on all construction drawings and staked in the field.
- Areas must be located within an acceptable conservation easement or other legal instrument that ensures perpetual protection of the proposed area. The easement or legal instrument must clearly specify how the natural area vegetation shall be managed and boundaries will be marked. Note: managed turf (e.g., playgrounds, regularly maintained open areas) is not an acceptable form of vegetation management.
- Area must have a minimum contiguous area of 10,000 square feet.
- Credit can also apply to waterway buffers if they meet other requirements contained herein and those of the City of Franklin Stormwater Management Ordinance.

Natural Area Conservation credit decreases WQ_v as follows:

- The runoff coefficient (R_v) remains constant (as if there were no Natural Area Conservation credit).

- However, **when WQ_v is calculated, the area that is in the Natural Area Conservation easement is subtracted from the total site area (A) in Equation 1.** For example, if the total area of development is 5 acres and 2 acres are in Natural Area Conservation, the A for calculating WQ_v would be 3 acres (5 acres – 2 acres).

Natural Area Conservation credit counts toward the pollutant removal goal as follows:

- The area within the Natural Area Conservation easement receives 100% TSS removal.

Site Design Credit #2: Drains to Buffer

This credit may be given when stormwater runoff is effectively treated by a stream buffer. Effective treatment constitutes treating runoff through overland sheet flow in a naturally vegetated or forested buffer. Under this credit, the areas draining via overland flow to the buffer should be subtracted from total site area (A in Equation 1) when computing water quality volume requirements. The design of the stream buffer treatment system must use appropriate methods for conveying flood flows.

To receive credit:

- The minimum undisturbed buffer width shall be 50 feet or the width set forth in the Stormwater Management Ordinance, whichever is greater. All otherwise qualifying natural areas including floodplains and waterway buffers can be used in calculation of this credit.
- The maximum contributing length shall be 150 feet for pervious surfaces and 75 feet for impervious surfaces.
- The average contributing slope shall be no more than 3% unless a flow spreader is used;
- Runoff shall enter the buffer as overland sheet flow. A flow spreader can be installed to ensure this, or if average contributing slope criteria cannot be met.
- Not applicable if overland flow filtration/groundwater recharge credit is already being taken.
- Buffers shall remain unmanaged other than routine debris removal, where roots are left intact.

Drains to Buffer credit decreases WQ_v as follows:

- The runoff coefficient (R_v) remains constant (as if there were no Drains to Buffer credit).
- However, **when WQ_v is calculated, the area that drains to the buffer via overland flow is subtracted from the total site area (A in Equation 1).** For example, if the total area of development is 5 acres and 1 acre drains to the buffer, the A for calculating WQ_v would be 4 acres (5 acres – 1 acre).

Drains to Buffer credit counts toward the pollutant removal goal as follows:

- The area that drains to the buffer receives 80% TSS removal.

Site Design Credit #3: Specially Engineered Vegetated Channel

This credit may be given when specially designed vegetated (grass) channels are used for water quality treatment. Under this credit, the areas draining to a grass channel should be subtracted from total site area when computing water quality volume requirements (A in Equation 1). For less dense developments the Low Impact Development Credit may apply. In addition, the post-development peak discharges will likely be lower due to a longer time of concentration for the site.

Note: This credit will not be granted if grass channels are being used as a limited application structural stormwater control towards meeting the 80% TSS removal goal for WQ_v treatment.

To receive credit:

- The credit can only be applied to moderate or low density residential developments (3 dwelling units per acre maximum).
- The maximum flow velocity for water quality design storm peak flow (Q_{wqp}) shall be less than or equal to 1.0 feet per second.
- The minimum residence time in the channel for the water quality storm shall be 5 minutes.
- The bottom width shall be a maximum of 6 feet. If a larger channel is needed use of a compound cross section is required.
- The side slopes shall be 3:1 (horizontal:vertical) or flatter.

Vegetated Channel credit decreases WQ_v as follows:

- The runoff coefficient (R_v) remains constant (as if there were no Vegetated Channel credit).
- However, **when WQ_v is calculated, the area that drains to the vegetated channel and the grass channel itself is subtracted from the total site area (A in Equation 1).** For example, if the total area of development is 5 acres and 2 acres drain to the vegetated channel, the A for calculating WQv would be 3 acres (5 acres – 2 acres).

Vegetated Channel credit counts toward the pollutant removal goal as follows:

- The area that drains to the grass channel receives 80% TSS removal.

Site Design Credit #4: Overland Flow Filtration

This credit may be given when overland flow filtration/infiltration zones are incorporated into the site design to receive runoff from rooftops or other small impervious areas (e.g., driveways, small parking lots, etc). This can be achieved by grading the site to promote overland vegetative filtering or by providing infiltration or "rain garden" areas. Impervious areas that are adequately disconnected and draining to these zones and engineered overland flow filtration/infiltration zones (i.e. not simply vegetated areas) can be deducted from total site area when computing the water quality volume requirements (A in Equation 1). An added benefit will be that the post-development peak discharges will likely be lower due to a longer time of concentration for the site.

To receive credit:

- Relatively permeable soils (hydrologic soil groups A and B) should be present.
- Runoff cannot come from hotspots such as car washes or car care facilities, landfills, junkyards, gas stations or other land uses that have the potential to have higher than normal pollutant loadings.
- The maximum contributing impervious flow path length shall be 75 feet.
- Downspouts shall be at least 10 feet away from the nearest impervious surface (including off site impervious areas) to discourage "re-connections" or flow concentration along a paved edge.
- The disconnection shall drain continuously through a grass channel, swale, filter strip or non-engineered vegetated area to the property line, buffer, or structural stormwater control.
- The length of the "disconnection" shall be equal to or greater than the contributing length.
- The entire vegetative "disconnection" shall be on a slope less than or equal to 3 percent.
- The maximum impervious area discharging to any one overland flow filtration zone shall not exceed 5,000 square feet.
- For those areas draining directly to a buffer, either the Overland Flow Filtration credit or the Drains to Buffer credit can be used, but not both.

Overland Flow Filtration credit decreases WQ_v as follows:

- The runoff coefficient (R_v) remains constant (as if there were no Overland Flow Filtration credit).
- However, **when WQv is calculated, the area that drains to the overland flow filtration/infiltration zone and the zone itself is subtracted from the total site area (A in Equation 1).** For example, if the total area of development is 5 acres and 2 acres drain to overland flow filtration zones, the A for calculating WQ_v would be 3 acres (5 acres – 2 acres).

Overland Flow Filtration credit counts toward the pollutant removal goal as follows:

- Areas qualifying for this credit receive an 80% TSS reduction value in pollutant reduction calculations.

Site Design Credit #5: LID Large Lot Subdivisions

This credit may be given when a group of low impact design techniques are applied to low and very low density residential development (i.e., 1 dwelling unit per 2 acres [du/ac] or lower). The credit can eliminate the need for structural stormwater controls to treat water quality volume requirements. This credit is targeted towards large lot subdivisions and will likely have limited application.

To receive credit:

For Single Lot Development:

- ❑ Total site impervious cover (including roadways/driveway) is less than 15%
- ❑ Lot size shall be at least two acres
- ❑ Rooftop runoff is disconnected in accordance with the criteria in Credit #4
- ❑ Grass channels are used to convey runoff versus curb and gutter (see Credit #3)

For Multiple Lots:

- ❑ Total impervious cover (including streets) shall be less than 15% of the area
- ❑ Lot areas should be at least 2 acres, unless clustering is implemented. Open space developments should have a minimum of 25% of the site protected as natural conservation areas and shall be at least a half-acre average individual lot size.
- ❑ Grass channels are be used to convey runoff versus curb and gutter (see Credit #3)
- ❑ Overland flow filtration/infiltration zones should be established (see Credit #4)

LID Large Lot Subdivisions credit decreases WQ_v as follows:

- ➢ **The requirement for structural practices to treat the water quality volume treatment requirements shall be waived.**

LID Large Lot Subdivisions credit counts toward the pollutant removal goal as follows:

- Pollutant removal requirement is waived.

1.5.4.1 Residential Subdivision Example

A typical residential subdivision design on a parcel is shown in Figure 1.5-3 (a). The entire parcel except for the subdivision amenity area (clubhouse and tennis courts) is used for lots. The entire site is cleared and mass graded, and no attempt is made to fit the road layout to the existing topography. Because of the clearing and grading, all of the existing tree cover and vegetation and topsoil are removed, dramatically altering both the natural hydrology and drainage of the site. The wide residential streets create unnecessary impervious cover and a curb and gutter system that carries stormwater flows to the storm sewer system. No provision for non-structural stormwater treatment is provided on the subdivision site.

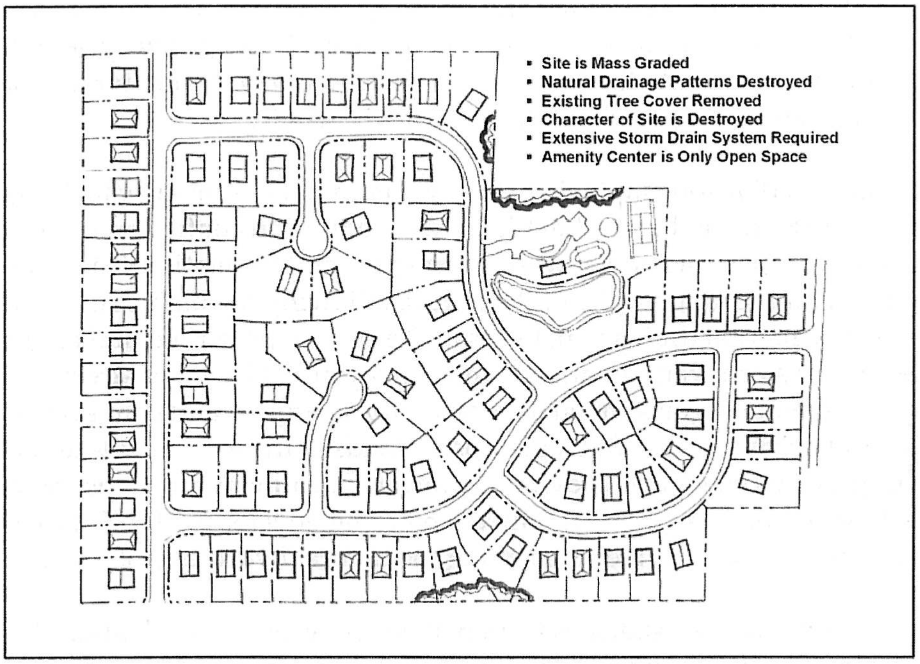
A residential subdivision employing stormwater impact-reducing site design practices is presented in Figure 1.5-3 (b). This subdivision configuration preserves a quarter of the property as undisturbed open space and vegetation. The road layout is designed to fit the topography of the parcel, following the high points and ridgelines. The natural drainage patterns of the site are preserved and are utilized to provide natural stormwater treatment and conveyance. Narrower streets reduce impervious cover and grass channels provide for treatment and conveyance of roadway and driveway runoff. Landscaped islands at the ends of cul-de-sacs also reduce impervious cover and provide stormwater treatment functions. When constructing and building homes, only the building envelopes of the individual lots are cleared and graded, further preserving the natural hydrology of the site.

Table 1.5-3 compares key statistics from both versions of the residential site. The site is 83.41 acres. The site designed with traditional design methods has designed a stormwater retention pond to meet the mandated stormwater detention and water quality criteria. The site designed using impact-reducing and integrated site design concepts, through reduction in impervious areas, has attained a 25% reduction (credit) in water quality volume needed to be treated.

Table 1.5-3 Comparison of Traditional and Reduced Impact Residential Site Designs

Parameter	Traditional	Reduced Impact
Number of Lots	96	102
Impervious Cover	20.75 acres	16.81 acres
% Impervious	25 %	20 %
Natural Conservation Area	2.19 acres	15.24 acres

There is also significant potential for cost savings in the reduction of paved surface area, graded area, and greater profit due to the increase in the number of lots.



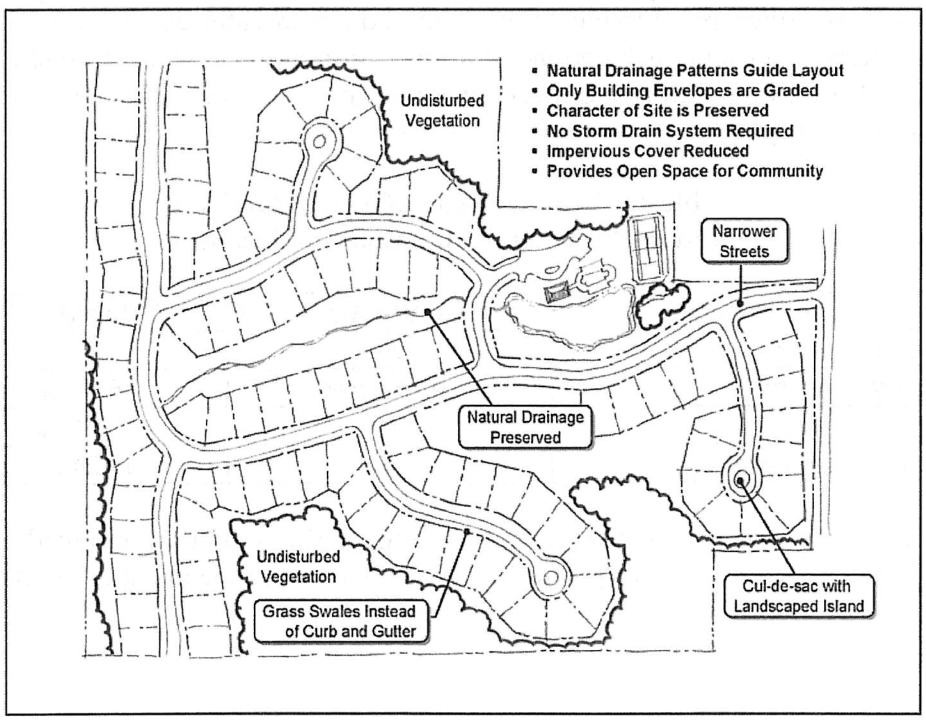


Figure 1.5-3 Comparison of a Traditional Residential Subdivision Design (above) and an Innovative Site Plan Developed Using Impact-Reducing Site Design Practices (below). (source: Georgia Stormwater Management Manual).

1.5.4.2 Commercial Development Example

Figure 1.5-4 (a) shows a typical commercial development containing a supermarket, drugstore, smaller shops and a restaurant on an outlot. The majority of the parcel is a concentrated parking lot area. The only pervious area is a small replanted vegetation area acting as a buffer between the shopping center and adjacent land uses. Stormwater quality and quantity control are provided by a wet extended detention pond in the corner of the parcel.

A impact-reducing site design commercial development can be seen in Figure 1.5-4 (b). Here the retail buildings are dispersed on the property, providing more of an "urban village" feel with pedestrian access between the buildings. The parking is broken up, and bioretention areas for stormwater treatment are built into parking lot islands. A large bioretention area which serves as open green space is located at the main entrance to the shopping center. A larger undisturbed buffer has been preserved on the site. Because of the bioretention areas and buffer provide water quality treatment, only a dry extended detention basin is needed for water quantity control.

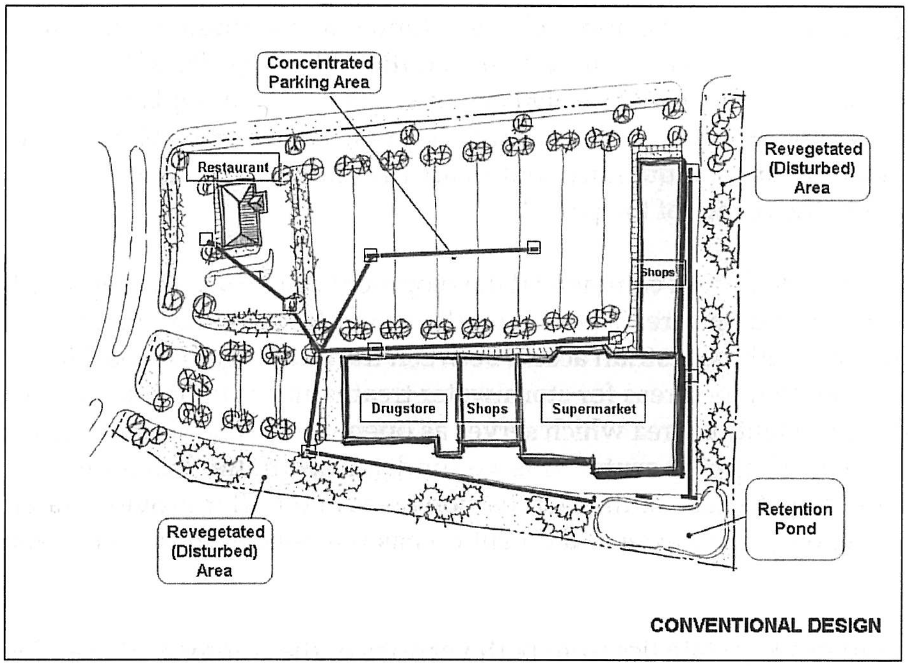
Table 1.5-4 compares key statistics from both versions of the commercial site. The site is 18 acres. The traditional site, to meet the mandated stormwater detention and water quality criteria has designed a stormwater retention pond.

Reduced impact designs employed on the improved site include: reduced clearing and grading, reduced parking footprint, sheet flow to pervious areas, undisturbed natural areas, parking lot islands used for stormwater treatment, and use of natural drainageways. The improved site's treatment of impervious areas through disconnection of roof drains, sheet flow to buffer areas, and creation of an undisturbed natural area attains a 50% reduction (credit) in water quality volume needed to be treated.

Table 1.5-4 Comparison of Traditional and Reduced Impact Commercial Site Designs

Parameter	Traditional	Reduced Impact
Impervious Cover	15.12 acres	12.38 acres
% Impervious	84 %	69 %
TSS Reduction	60%	80%
Natural Conservation Area	-0- acres	3.50 acres

In addition to the other savings, the reduction of impervious areas, use of upstream treatment to handle much of the water quality volume and longer flow paths reduce the need to treat runoff for peak flow creating a 25% reduction in the volume needed for detention volume.



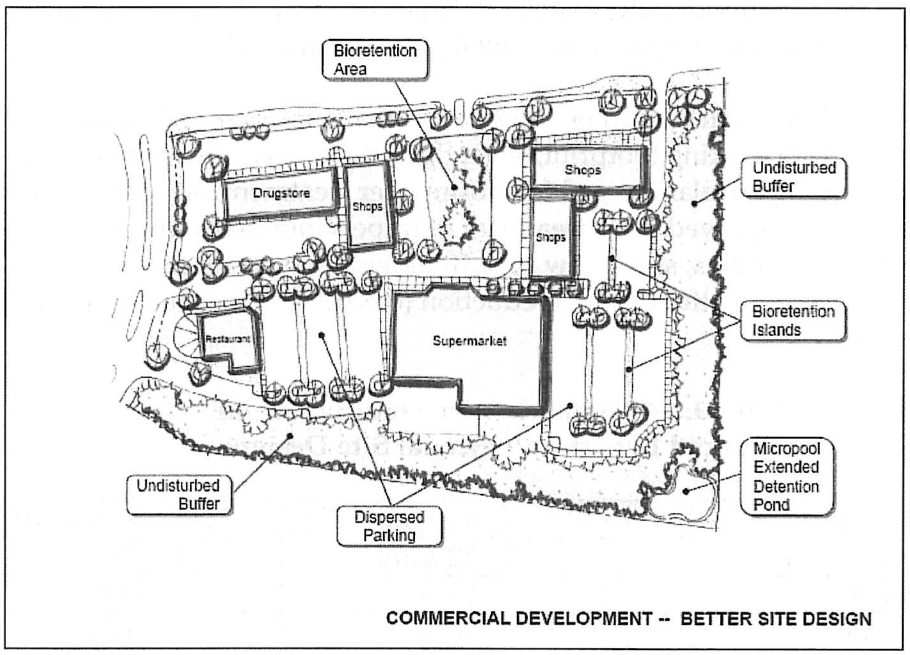


Figure 1.5-4 Comparison of a Traditional Office Park Design (above) and an Innovative Site Plan Developed Using Impact-Reducing Site Design Practices (below). (source: Georgia Stormwater Management Manual)

1.5.5 *Step 4 – Choose Appropriate Structural Stormwater BMPs*

Structural stormwater controls or permanent stormwater controls (sometimes referred to as *structural or permanent best management practices* or *BMPs*) are engineered stormwater management facilities designed to treat stormwater runoff and/or mitigate the impact of stormwater runoff. These BMPs have been assigned a TSS removal capability, based upon existing research, and can be used by developers to meet the pollutant reduction requirement of 80% TSS removal and the integrated stormwater sizing criteria. These recommended controls are divided into *general application* and *limited application* structural controls.

General Application BMPs

General application BMPs are recommended for use with a wide variety of land uses and development types. These structural controls have a demonstrated ability to effectively treat the Water Quality Volume (WQ_v) and are presumed to be able to remove 80% of the total annual average TSS load in typical post-development urban runoff when designed, constructed and maintained in accordance with recommended specifications. Several of the general application structural controls can also be designed to provide water quantity control; i.e., downstream overbank flood protection (Qp) and/or extreme flood protection (Q_f). General Application BMPs are the recommended stormwater management facilities for a site wherever feasible and practical.

Limited Application BMPs

Limited application BMPs are those that are recommended only for limited use or for special site or design conditions. Generally, these practices: (1) cannot alone achieve the 80% TSS removal requirement, (2) are intended to address hotspot or specific land use constraints or conditions, and/or (3) may have high or special maintenance requirements that may preclude their use. Limited application controls are typically used for *water quality treatment only.*

Some of these controls can be used as a pretreatment measure or in series with other structural controls to meet pollutant removal goals. Limited application structural controls should be considered primarily for commercial, industrial or institutional developments.

Structural stormwater BMPs acceptable for use in the City of Franklin are listed with TSS removal capabilities in the table below. **For detailed descriptions of each structural control along with design criteria and procedures, please refer to Metro Nashville's Stormwater Management Manual, Volume 4.**

Table 1.5-5 Impact-Reducing Site Design Practices that Provide for Site Design Credits

Structural Control	TSS Removal (%)
General Application BMPs	
Wet Pond	80
Stormwater Wetland	80
Bioretention Area	80
Sand Filter	80
Enhanced Swale	80
Limited Application BMPs	
Filter Strip	50
Grass Channel	50
Organic Filter	80
Underground Sand Filter	80
Submerged Gravel Wetland	80
Infiltration Trench	80
Gravity (Oil-Grit) Separator	40
Proprietary or Manufactured BMP	50
Dry Extended Detention Basin	60

Proprietary or Manufactured BMPs

Below is a list of proprietary BMPs, or manufactured stormwater treatment devices, approved for use in Franklin. However, some of these BMPs do not have established pollutant removal data. Franklin considers proprietary BMPs at Limited Application BMPs because of the lack of historic pollutant removal data or because of high maintenance requirements. Therefore, **these devices cannot be used as the only water quality treatment for a site.** They can, however, be used in a "treatment train", in combination with other water quality controls mentioned in this document.

Currently, Franklin has not established or adopted submittal requirements or general guidelines for test requirements to demonstrate the pollutant removal capabilities of proprietary BMPs. New units are not being approved at this time.

Proprietary or manufactured BMPs approved for use in the City of Franklin include:

- Vortechs Baffle Box
- Stormceptor
- Downstream Defender
- ADS
- Sun Tree Nutrient Baffle Box
- Crystal Stream

Inspection and Maintenance of BMPs

Each structural stormwater BMP installed on a site requires maintenance so that it functions properly and continues to help meet the water quality goal for the site. Therefore, a BMP-specific maintenance agreement for each development site is required. The maintenance agreement must include at least the following:

1. Descriptions of the stormwater management system and each control (both structural and non-structural) that comprises the system
2. Schedules for inspections
3. Regular maintenance tasks and responsible parties

The property owner, under the maintenance agreement, shall be responsible for inspecting and maintaining the BMPs and for submitting inspection reports annually to show that facilities have been maintained and are continuing to function as designed. Information for preparing and submitting the Long-Term Maintenance Plan can be obtained from the City of Franklin Engineering Department.

Suitability of Structural BMPs to Meet Stormwater Management Requirements

Structural controls should be consider only after all reasonable attempts have been made to minimize stormwater runoff and maximize its control and treatment though the impact-reducing site design methods described in Section 1.5.2. After the site has been designed with these methods in mind, one or more appropriate controls will need to be selected to handle the stormwater runoff storage and treatment requirements calculated using the integrated stormwater sizing criteria, Section 1.5.3. Given that many structural controls cannot meet all of the sizing criteria, it is highly recommended and encouraged that two or more controls are used in series to form what is known as a stormwater "treatment train."

Section 1
Introduction

1.1 Background and Purpose

This manual of Best Management Practices (BMPs) has been compiled for the City of Franklin to assist contractors, developers, and various businesses and industries to comply with the guidelines set forth by the National Pollution Discharge Elimination System (NPDES) Phase II Rule. This manual will assist the City of Franklin by requiring use of practices that benefit water quality, an overall goal of the Phase II program. Specifically, this manual will assist in BMP selection, design, and implementation.

The City of Franklin is experiencing rapid development which requires special emphasis on Erosion Prevention and Sedimentation Control (EP&SC) during construction, as well as permanent structures to manage the increased stormwater runoff created by an increase in impervious areas. In addition, there are BMPs to assist commercial and industrial facilities whose businesses may potentially affect stormwater quality or quantity.

The fact sheets in this manual are designed for easy reference. They are Categorized, focused, and concise to allow easy access and expedient use. Each fact sheet can be used as a stand-alone document that may be distributed to facilitate focused discussion about design and/or implementation of each management practice. There are BMPs that require structural practices while many are non-structural practices where everyday activities may be performed in a manner that limits the impact of stormwater runoff to surface water quality.

1.2 Stormwater Quality and Quantity

Currently the City of Franklin has a Stormwater Management Ordinance, which serves as the City's primary stormwater management guideline. This manual is designed to support and enforce the Ordinance by way of elaborating on various practices, as well as offering specific guidance for selection of BMPs, minimum specifications and requirements, and more complete information about various practices. The Ordinance gives authority to the BMP manual in section 7.3.

Stormwater quantity management involves slowing, detaining, and/or controlling the amount and flow rate of runoff from "major" storm events ranging from a 10 to 500-year statistical storm frequency. Considering the increase in impervious areas due to increased development, an increase in volume places a new emphasis on stormwater quality.

The City of Franklin is now requiring stormwater quality management techniques be applied to new development and redevelopment in the form of structural and non-structural Best Management Practices (BMPs). Stormwater quality management involves pollutant control, capture, and /or treatment. Some of the pollutants are referred to as "point sources" and appear in the form of regulated discharges, spills, dumping, illicit connections, etc. This manual briefly discusses minimizing the chance of unregulated point sources, but primarily focuses on nonpoint source pollution.

1.3 Sources of Pollution and their Impacts

1.3.1 Erosion Overview

Short-term stormwater quality management predominately focuses on erosion prevention and sedimentation control (EP&SC) for construction sites. However, for some fully developed sites, EP&SC can also be a concern. Soil erosion is the process by which soil particles are removed from land surfaces by wind, water or gravity. Natural erosion generally occurs at slow rates. However, the rate of erosion increases when land is cleared or altered and left disturbed. Erosion rates will increase when flow rates and velocities discharged from a site exceed the erosive range.

Clearing and grubbing activities during construction remove vegetation and disrupt the structure of the soil surface, leaving the soil susceptible to rainfall erosion, stream and channel erosion, and wind erosion if left untreated. Ultimately, the material suspended by erosion settles during sedimentation in downstream reaches.

There are negative influences on streams and rivers when sediment enters the waterways. As sediment volumes increase in waterways the overall capacity decreases. This causes increases in flooding as well as creating excessive maintenance needs.

1.3.1.1 Water Erosion

Rainfall events begin the water erosion process by dislodging minute soil particles. These soil particles then become suspended in the water droplet. The sediment laden water droplets accumulate on the soil until a sufficient quantity has developed to begin flowing under the forces of gravity.

The initial flow of sediment laden water generally consists of a thin, slow-moving sheet, known as sheet flow. In most cases sheet flow does not prove to be highly erosive, however it does begin the transport of the sediment that was previously suspended. Irregularities in soil surface and uneven topography will usually cause sheet flow to become concentrated into rivulets where flow causes an increase in velocity and erosive energy. This increase in erosive energy of water flowing in rivulets creates small grooves, or rills, in the soil surface.

Rill erosion of the soil surface concentrates flows, which increases flow velocity and erosive energy due to gravitational forces. This results in deeper and wider rills that may join together with adjacent rills. Typically, rills run parallel to the slope and each other. In addition, rills are small enough to be stepped across, and are usually enlarged by direct erosion of the rill's sides and bottom by the action of flowing water.

The joining together of several adjacent rills, or sufficient enlargement of a single rill, begins gully erosion. In most cases gullies run parallel to the slope and may have one or more lateral branches. Gullies are enlarged by the following four key actions:

1. Gullies often have a "head cut" at the upstream end, which progresses its way upstream as water flowing into the gully erodes away the lip of the head. A waterfall working its way upstream can exemplify this. This can be seen in the picture below.

Severe gully erosion.

2. The flow in a gully tends to under cut the banks. Once the banks are sufficiently under cut, the banks will collapse into the gully where the collapsed soil is then washed away.

3. The collapse of banks into the gully causes flowing water to be diverted around the temporary blockage of soil. This temporary blockage of soil increases the velocity along one or both banks, which results in increased bank erosion.

4. The concentration of flows in the gully may result in scour of the gully floor until a stable slope is obtained.

1.3.1.2 Stream and Channel Erosion

- Construction activities often require the disturbance of streams and channels. Once vegetation or other bank protection measures are disturbed, flows may begin to erode the unprotected soil.

- Construction activities often require the disturbance of flow. However, this should only happen when traversing banks such as temporary stream crossing, culvert installation, bridge construction, etc. By diverting flows within the channel, velocities are generally increased in some areas to compensate for decrease in other areas. The increase in velocity may exceed those normally experienced by the channel, resulting in bank erosion and bottom scour.

- Increasing the quantity and flow rate to streams and channels often results from construction activities and construction of facilities that increase the quantity and rate of runoff as well as how runoff is conveyed to the discharge point. The increased quantity and rate of flow can cause bank erosion and bottom scour.

1.3.1.3 Wind Erosion

Dust is defined as solid particles or particulate matter small enough to remain suspended in the air for a period of time and large enough to eventually settle out of the air. Dust from a construction site originates as inorganic particulate matter from rock and soil surfaces and material storage piles. The majority of dust generated and emitted into the air at a construction site is related to earth moving, demolition, construction traffic on unpaved surfaces, and wind over disturbed soil surfaces.

1.3.1.4 Factors Influencing Erosion

There are five primary factors that influence erosion: soil characteristics, vegetative cover, topography, climate, and rainfall.

Soil Characteristics – Particle size, particle gradation, organic content, soil structure, and soil permeability are all characteristics that contribute to the determination of erodibility. These characteristics affect the stability and infiltration capacity of the soil. Less permeable soil has increase risk of runoff and erosion. Typically soils that contain high percentages of silts and clays are the most erodible.

Channel flow is also affected by soil characteristics in that tractive-force or shear stress developed by flowing water over the channel banks and bottom may cause soil particles to move and become suspended into the runoff. The "permissible shear" stress indicates the stress that the channel banks and bottom can sustain without jeopardizing stability. It is possible to increase the allowable shear stress in the channel by utilizing "soft/green" or "hard" armoring on the channel bottoms and banks.

Vegetative Cover – Vegetative cover creates an erosion shield by stabilizing the soil. In addition, vegetative cover protects soil from direct rain, and also decreases the velocity of runoff. This allows greater infiltration as well as maintaining the soil's capacity to absorb water. Vegetative root structures create a favorable soil structure, improving its stability and permeability.

Topography - The slope, length and steepness are key elements needed to determine the volume and velocity of runoff. Increases in slope length, and/or steepness causes an increase in the runoff rate, and consequently, increase the potential of erosion.

Climate - High precipitation areas as well as areas with freeze/thaw cycles have significant effects on soil stability and structure.

Rainfall - Frequency, intensity, and duration are fundamental factors in determining the amounts of erosion produced. In Tennessee, the erosion risk period is typically highest in the wet season (typically December through May), which coincides with the period of minimal vegetative cover.

1.3.2 Sedimentation Overview

Once eroded, soil particles may travel anywhere from a few inches to many miles away before gravity causes them to settle. This process of soil particles settling is known as sedimentation. Excessive levels of sedimentation can create problems such as clogging storm drains, blocking streams and channels, damage to habitat, and in some cases result in formation of habitats in undesirable locations. The objectives set forth by the ordinance require 90% total suspended solids removal of the first flush. Section 6.2.9 of the ordinance elaborates on this requirement. Slowing of the flow of water or air causes soil particles to settle, while creating conditions of rapid and/or turbulent flow prevents particles from settling. Detention basins create an environment for sediment to settle out before exiting the site.

Wet detention basins prove to be very effective in removals. Removal efficiencies for various parameters in a wet detention pond are illustrated in the table below.

REMOVAL EFFICIENCIES FROM WET DETENTION PONDS	
Parameter	**Percent Removal**
Total Suspended Solid	*50-90*
Total Phosphorus	*30-90*
Soluble Nutrients	*40-80*
Lead	*70-80*

Zinc	*40-50*
Biochemical Oxygen Demand or Chemical Oxygen Demand	*20-40*

1.3.3 Nutrients

Fertilizers, pesticides, construction chemicals, and solid waste contain phosphorus and nitrogen, which can result in excessive or accelerated growth of vegetation or algae. This increase in vegetation results in the impairment of lakes and other water sources and the growth of algae causes the depletion of dissolved oxygen potentially resulting in fish kills.

1.3.4 Oxygen Demanding Substances

The biological decomposition of organic matter in stormwater depletes the amount of dissolved oxygen (DO), which causes biochemical oxygen demand (BOD). BOD measures the degree of dissolved oxygen depletion by expressing the amount of easily oxidized organic matter present in water. In addition, certain non-organics materials in the water can intensify DO depletion.

1.3.5 Metals

Artificial surfaces such as galvanized metal, paint, or preserved wood contain metals that can enter stormwater as their surfaces corrode, flake, dissolve, decay, or leach. These metals that are found in urban stormwater are often from cars and trucks. Over half the trace metal load carried in stormwater is associated with sediments to which these eroded metals attach. Heavy metals are of concern because they are toxic to aquatic organisms, can be bioaccumulative, and have the potential to contaminate drinking water supplies.

1.3.6 Pesticides

Pesticides are herbicides, insecticides, and rodenticides that are commonly used on construction sites, lawns, parks, golf courses, etc. Excessive or improper application of theses pesticides may result in direct water contamination, indirect water pollution by aerosol drift, or erosion of treated soil and subsequent transport into surface waters.

1.3.7 Oil, Grease, and Fuels

These products are widely used and may spill, leak, or be dumped on the ground where they can wash into waterways. Sources include leakage during normal vehicle use, hydraulic line failure, spills during fueling, and inappropriate disposal of drained fluids. These products can cause harm to plant and animal life.

1.3.8 Other Toxic Chemicals

Synthetic organic compounds such as adhesives, cleaners, sealants, and solvents are often applied, and may be improperly stored and disposed. Accidental spills or deliberate dumping of these chemicals onto the ground or into storm drains causes environmental harm to receiving waters.

1.3.9 Miscellaneous Wastes

Miscellaneous wastes include wash water from concrete mixers, paints and painting equipment cleaning activities, solid organic wastes resulting from trees and shrubs removed during land clearing, wood and paper materials derived from packaging of building products, food and containers, such as paper, aluminum, and metal cans, industrial or heavy commercial process wash/cooling water, vehicle washing, other commercial or industrial wastes and sanitary wastes. Periodic spills or storage of these materials outside can result in these materials being transported to surface waters during storm events. The discharge of these waters can lead to unsightly and polluted receiving waters.

1.4 BMP Selections

1.4.1 Define BMP Objectives

BMP objectives must address development and construction as well as existing industry, businesses, and private parties whose activities may contribute to overall water quality. These activities are all unique and require specific knowledge of pollution risks associated with each specific activity. This knowledge is essential in selecting BMPs effectively. Each unique project has specific risks that be addressed through the BMPs selected for use. In order to reach this goal specific project risks are identified, BMP objectives are developed, and BMPs are selected. The following BMP objectives supplement the standards set forth by the City's Stormwater Management Ordinance:

1. **Practice Good Housekeeping**: Proper management of pollutant sources and modification of construction activities can prevent pollutants from draining or being transported off-site.

2. **Contain Waste**: Dispose of all construction waste in designated areas, and keep stormwater from flowing on to or off of these areas.

3. **Minimize Disturbed Areas**: Land clearing should take place only in areas that will be under active construction within a few months of the time of clearing. Phasing clearing of a large development is recommended. Land clearing during the rainy season should be avoided if at all possible Sensitive areas such as steep slopes, buffers, and natural watercourse should never be disturbed is at all possible.

4. **Stabilize Disturbed Areas**: Temporary stabilization techniques should be utilized in areas where there are disturbed soils that are not undergoing active construction. Upon final completion of a construction activity, permanent landscaping and stabilization should be applied.

5. **Protect Slopes and Channels**: Steep and unstable slopes should not be disturbed if they are outside of the approved grading plan area. Runoff should be conveyed from the top of the slope in a safe manner ensuring that the slope is stabilized as soon as possible. Natural Channels should not be disturbed if at all possible. Temporary and permanent channel crossings require stabilizing as quickly as possible to ensure that increases in runoff velocity caused by the project do not erode the channel.

6. **Control Site Perimeter**: Upstream runoff should be diverted either around or through the construction project in a safe manner. These diversions should be designed to ensure that downstream property would not be damaged. In addition, all runoff exiting the construction site should be free of excessive sediment, and other pollutants.

7. **Control Internal Erosion**: Sediment laden water should be detained or otherwise treated within the site to avoid potential pollution to external waterways.

Site characteristics and specific contractor activities affect the potential for erosion and pollution by other constituents used on the construction site. While determining BMP objectives site conditions and climatic factors should be considered.

1. Site conditions include the following:

- Soil type, including underlying soil strata that are likely to be exposed to stormwater.

- Natural terrain and slope.

- Final slopes and grades
- Location of concentrated flows, storm drains, and streams.
- Existing vegetation and ground cover.

2. Climatic factors include the following:

- Seasonal rainfall patterns.
- Appropriate design storm, which takes into account quantity, intensity, and duration of rainfall.

3. Type of Construction activity.
4. Construction schedules, construction sequencing and phasing of construction.
5. Size of construction project and areas to be graded.
6. Location of the construction activity relative to adjacent uses and public improvements.
7. Cost-effectiveness considerations.
8. Types of construction materials and potential pollutants present or that will be brought on-site.
9. Floodplain, Floodway, and buffer requirements.

1.4.2 Determine BMP Categories

Once the BMP objectives are defined, BMP categories must be determined. In order to determine the BMP categories, a plan for the project will be needed. This plan should contain enough detail that draining patterns, topography, existing and permanent stormwater control structures can be located with ease. The plan will be required in order to obtain a Stormwater Management Permit, which is required for all development and redevelopment as identified in Sections 2, and 6 of the Ordinance. The plan should identify all of the following information in addition to any requirements set forth by the ordinance regarding this matter:

1. Stormwater entrance and exiting locations. Sheet and Channel flow for the existing and final grading contours should be included. This should

be in accordance with the master stormwater management plan for the specific watershed. (See section 6.2.3, and 6.2.4 of the Ordinance)

2. Identify locations of steep slopes and unlined channels that are subject to high rates of erosion. Long, steel slopes over 100 feet in length are considered as areas of moderate to high erosion potential. Soil bioengineering is preferred for stabilization over rip rap, and other hard armoring techniques. (See section 6 of Ordinance)

3. Categorize slopes as:

   Low Erosion Potential (0 to 5 percent slope)

   Moderate Erosion Potential (5 to 10 percent slope)

   High Erosion Potential (slope greater than 10 percent)

   (Section 1 of the Ordinance discusses variables that may change the rate and volume of runoff.)

4. Identification of sensitive areas that should not be disturbed such as wetlands, springs, sinkholes, floodplains, floodways, sensitive areas or buffers, including other areas where site improvements will not be constructed. Clearing limits should be identified to prevent and disturbance during construction activities. (see section 6 of Ordinance)

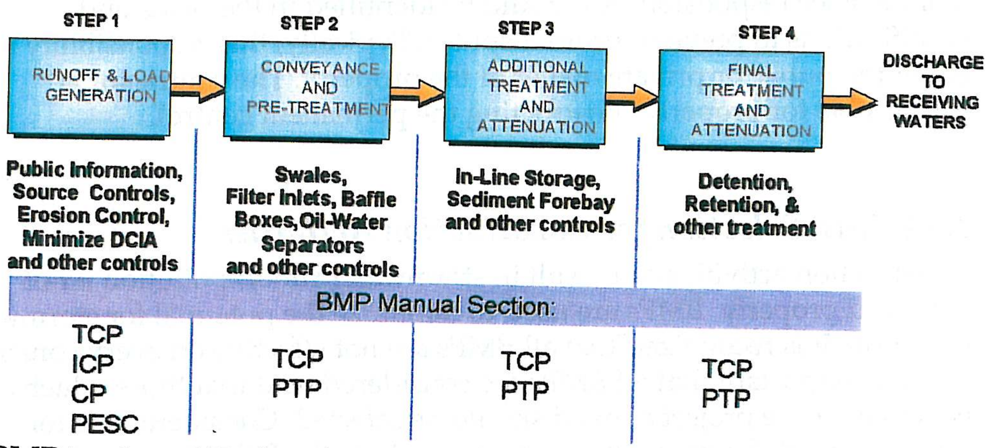
5. Identification of tributary areas for each outfall location should be included. The approximate area of each tributary should be calculated.

6. Identification of locations where contractor activities may have a risk of causing a runoff or polluted discharge. (See section 6 for specific regulation regarding this matter)

This plan will allow easy identification of BMP categories that need to be considered on a particular construction project. Planning before construction, and phasing construction activities always proves to be more cost effective than treatment of stormwater after the fact. Preventative maintenance is simpler, and less costly, than correcting a problem that has occurred.

Once BMP objectives have been determined, the BMP treatment train illustrated in Figure 1-1 can be utilized. The BMP treatment train is used to determine BMP objectives that will be met by various BMPs. Many BMPs can achieve more than one objective, which should be taken into account when selecting BMPs. This allows for selecting the most cost-effective BMP. For example, it is not always necessary to install extensive sediment trapping controls during construction. In fact, sediment trapping should be used only as a short-term measure for active construction areas, and replaced by permanent stabilization measures as soon as possible. However, it should be noted that perimeter/outfall control in the form of permanent detention ponds should be built first and used as temporary sediment control during construction. After construction is complete and tributary area is stabilized, the permanent outlet configuration can be reestablished.

Figure 1-1



BMP treatment Train

1.4.3 Temporary and Permanent BMPs

Temporary BMPs are designed to address construction activities, while permanent BMPs address long-term stormwater management objectives. Planning for both short and long term goals allows for favorable results with respect to cost and performance.

Temporary BMPs include many different "good housekeeping" methods as well as short term EP&SC activities. The steps involved in utilizing temporary BMPs includes design, review by the City of Franklin, and implementation. The construction site operator and/or licensed professional engineer should be responsible for the design of these BMPs. In some sensitive and more difficult cases, design will require a licensed professional engineer. The contractor bears the responsibility of constructing, maintaining, implementing, and seeking help when it is apparent that the BMPs are not meeting their objectives.

Permanent BMPs are the final improvements to the configuration of the project. They are designed for long-term management of stormwater pollution. Permanent BMPs are typically selected during the planning phase, in conjunction with the approval of the tentative plan designed during the design phase of a project. On occasion, revision or addition to permanent BMPs during construction may be necessary due to unforeseen natural or manmade factors.

Permanent BMPs may include swales, sediment or detention ponds, and a variety of other features. Licensed professional engineers are responsible for selection of these management practices. These practices should be included in the plans and specifications for the project. In addition, the long-term maintenance responsibilities should be identified in the plans and specifications to prevent future disputes. Typically, this responsibility if left to either the public or private owner of the property. The contractor is responsible for properly constructing the permanent control.

1.4.4 BMP Selection for Construction Activities

Construction activities can result in stormwater runoff pollution if not managed properly. BMPs are used to minimize the potential for stormwater pollution. It is recognized that all BMPs are not effective on every construction site. It is important that all BMPs are considered, and that those which are effective for the project at hand should be selected. Considerations for selecting BMPs for contractor activities include the following:

1. Is it expected to rain? BMPs may be different on rainy days vs. dry days, winter vs. summer, etc. For instance, a material storage area may be covered with a tarp during the rainy season, but not in the summer. However, it should be noted that plans should be made for some amount of rain even if it is not expected to generate a flooding event.

2. How much material is used? Less intensive BMP implementation may be necessary if a "small" amount of pollutant containing material is used (however, remember that different materials pollute in different amounts).

3. How much water is used? The more water used and wastewater generated, the more likely that pollutants transported by this water will reach the stormwater system or be transported off-site. Washing out one concrete truck on a flat area of the site may be sufficient (as long as the concrete is safely removed later), but a pit should be constructed if a number of trucks will be washed out at the same site.

4. What are the site conditions? BMPs selected will differ depending on whether the activity is conducted on a slope or flat ground, near a stormwater structure or watercourse, etc. Anticipating problems and conducting activities away from certain sensitive areas will reduce the cost and inconvenience of performing BMPs.

5. What about accidents? Pre-establishing a BMP for each conceivable pollutant discharge may be very costly and significantly disrupt construction. As a rule of thumb, establish controls for common (daily or weekly) activities and be prepared to respond quickly to accidents. Define the difference, not everything can be called an accident and maybe classified as negligent disregard of proper practices.

Therefore, keep in mind that the BMPs for contractor activities are suggested practices that may or may not apply in every case. Construction personnel should be instructed to develop additional or alternative BMPs that are more cost-effective for a particular project. The best BMP is a construction work force aware of the pollution potential of their activities and committed to a clean worksite.

1.4.5 BMP Selection for EP & SC Activities

BMPs for erosion and sediment control are selected to meet the BMP objectives based on specific site conditions, construction activities, and cost-effectiveness. Different BMPs may be needed at different times during construction since construction activities are constantly changing site conditions.

EP& SC must begin with the initial prevention of erosion. This can be accomplished through soil protection techniques that will prevent the runoff of soil particles. Erosion and sedimentation will most probably occur to some degree due to active construction areas, and BMP s must be selected to take care of these issues once they have occurred. SC BMPs allow sedimentation to be removed from flows before these flows exit the construction site. Consequently, the best protection on active construction sites is generally obtained through simultaneous application of both EP BMPs and SC BMPs. This combination is effective because it prevents most erosion before it begins and has the ability to capture sediments that become suspended before the transporting flows leave the construction site.

The following general items are provided to aid in preparing the project plans and choosing appropriate erosion and sediment control BMPs:

<u>Minimize Disturbed Areas</u> - Project layout and schedule should be compared with on-site management measures that where appropriate, can limit the exposure of the project site to erosion and sedimentation. Section 6 of the ordinance sets standards that require responsible construction practices. The following BMPs should be considered in order to reach desired goals:

1. Do not disturb any portion of the site unless an improvement is to be constructed there immediately.

2. Staging and timing of construction, grading, clearing, etc. can minimize the size of exposed areas and the length of time the areas are exposed and subject to erosion. For example, only areas that are actively involved in cut and fill operations or are otherwise being graded should be exposed.

3. Retain existing vegetation and ground cover where feasible, especially along watercourses and along the downstream perimeter of the site.

4. The first task when construction begins is to construct outfall detention or perimeter sedimentation controls with weirs/berms, and temporary sedimentation control barriers. Construction of permanent stormwater control facilities such as detention basins should occur towards the beginning of the project and used for sediment trapping, slope stabilization, velocity reduction, etc. during the construction period.

5. Construction should be competed as quickly as possible.

6. Landscaping or other stabilization techniques should be installed immediately after the land has been graded to its final contour.

7. Denuded areas should be at a minimum during the wet months of December through May.

<u>Stabilize Disturbed Areas</u> – Stabilization is very important because it protects the soil from being eroded away. Stabilization techniques may include vegetative, chemical, or physical soil coverings. It is important to keep in mind that any soil which is exposed is subject to erosion due to a rainfall event, runoff flowing over the soil, wind blowing across that soil, and vehicles driving on the soil. Consequently, it is important that all soil is covered, other than that which is undergoing active construction. Locations on a construction site that are more susceptible to erosion are:

1. Slopes

2. Highly erosive soils

3. Construction entrances

4. Stream channels

5. Soil stockpiles

<u>Site Perimeter</u> – BMPs for regulating flow in and out of the site perimeter should be a priority. The following ideas should be considered:

1. Disturbed areas or slopes that drain toward adjacent properties, storm drain inlets or receiving waters, should be protected with temporary linear barriers (continuous berms, silt fences, sand bags, etc.) to reduce or prevent sediment discharge while construction in the area is active. In addition, the contractor should be prepared to stabilize those soils with EP measures prior to the onset of rain.

2. When grading has been completed, the areas should be protected with EP controls such as mulching, seeding, planting, or emulsifiers. The combination of EP measures and SC measures should remain in place until the area is permanently stabilized.

3. Significant offsite flows (especially concentrated flows) that drain onto disturbed areas or slopes should be controlled through use of continuous berms, earth dikes, drainage swales, and lined ditches that will allow for controlled passage or containment of flows.

4. Concentrated flows that are discharged off of the site should be controlled through outlet protection and velocity dissipation devices in order to prevent erosion of downstream areas.

5. Perimeter controls should be placed everywhere runoff enters or leaves the site. They are usually installed just before clearing, grubbing, and rough grading begin. Perimeter controls for all but the smallest projects will become overloaded by both runoff and sediment. Additional controls within the interior of the construction site should supplement perimeter controls once rough grading is complete.

<u>Internal Swales and Ditches</u> – Until permanent facilities have been constructed flows are directed toward internal swales, curbs, and ditches. Design and implementation criteria should include the following:

1. Temporary stormwater facilities are susceptible to erosion from concentrated flows, and should be stabilized through temporary check dams, geotextile mats, and under extreme erosive conditions by lining with concrete.

2. Long or steep slopes should be terraced at regular intervals (per local requirements) in order to slow down the runoff, and to allow for small amounts of sediment to settle out.

3. Slope benches may be constructed with either ditches along them or back-sloped at a gentle angle toward the hill. These benches and ditches intercept runoff before it can reach an erosive velocity and divert it to a stable outlet.

4. A rough surface such as tall grass can be installed to reduce overland flow velocities.

Internal Erosion - After all erosion and sediment control BMPs have been utilized, excessive sediment should be removed from stormwater both within and along the perimeter of the project site. To prevent erosion temporary barriers or traps should slow the velocity of sediment-laden water. This flow should then enter a pond where soil particles may settle. Appropriate strategies for implementing sedimentation controls include:

1. Sediment-laden water should be directed to temporary sediment traps.

2. Locate sediment basins and traps at low points below disturbed areas.

3. Existing and proposed storm drainage structures should be protected from sediment clogging by implementation of inlet protection for area drains and curb inlets.

4. Temporary sediment traps or ponds should be constructed at stormwater outfalls for the site.

5. Stormwater detention ponds should be excavated early in the project so that they can serve as sedimentation ponds during construction, remove accumulated sediment, and landscape the ponds when the upstream drainage area is stabilized.

6. Temporary sediment barriers such as:

    - Continuous Berms
    - Silt Fences
    - Straw Bale Barriers
    - Sand Bag Barriers

- Brush or Rock Filter

<u>Stormwater Inlets and Outfalls</u> – All stormwater inlets, including drop inlets, and pipe inlets, should be protected from sediment intrusion if the area draining to the inlet has been disturbed. This protection may include sand bags, sediment traps, or other similar devices. In addition internal outfalls must be protected to reduce scour from high velocity flows leaving pipes or other drainage facilities.

1.4.6 BMP Selection for Structural Treatment Controls

The developer proposes most permanent BMPs during the early planning process of a project. Typically, there is not a single BMP that addresses all long-term stormwater quality problems. Instead, a multi level strategy will be worked out with the City of Franklin, which incorporates source controls, a series of on-site treatment controls, and community-wide treatment controls. This concept is presented in section 1.4.2, which discusses the BMP treatment train.

In most cases permanent BMPs are implemented most effectively when they are tied in with the actual project design. When stormwater controls are considered as part of the design they are conceptually planned out and consequently, more effective. The following should be considered in the design process.

1. Is a detention/retention facility required for flood control? Often, facilities are required to maintain peak runoff at predevelopment levels to reduce downstream conveyance system damage and other costs associated with flooding. Most permanent BMPs can be incorporated into flood control detention/retention facilities with modest design refinements and limited increase in land area and cost. Please refer to section 6.2.6 for the stormwater detention policy set by the City's Ordinance.

2. Planned open spaces that have slopes less than 5% may be merged with stormwater quality/quantity facilities. Such integrated, multi –use areas may achieve several objectives at a modest cost.

3. Infiltration BMPs may serve as groundwater recharge facilities although soil conditions are critical to their succeed. Detention/retention areas may be created in landscaped areas of the project, and vegetated swales/filters may be used as roadside/median or parking lot median vegetated areas.

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1.5 References

California Storm Water Best Management Practice Handbooks, *Camp Dresser & McKee et.al. for the California SWQTF, 1993.*

Caltrans Storm Water Quality Handbooks, *Camp Dresser & McKee et.al. for the California Department of Transportation, 1997.*

Chow, Ven Te. Open Channel Hydraulics, *McGraw-Hill, Inc., 1959.*

Landcare Field Guide – An Introduction to Land Degradation, Cullen Gunn.

Roesner, L.A., Aldrich, J., Hartigan, J.P., et.al., Urban Runoff Quality Management – WEF Manual of Practice No. 23 / ASCE Manual and Report on Engineering Practice No. 87, *1998.*

Sevenmile Creek Basin Pilot Stormwater Quality Master Plan, Camp Dresser & McKee et.al. for the Metropolitan Nashville and Davidson County Department of Public Works, February, 2000.

Storm Water Technology Fact Sheet- Wet Detention Ponds, United States Environmental Protection Agency, 832-F-99-048, September 1999.

Storm Water Management for Construction Activities – Developing Pollution Prevention Plans and Best Management Practices, U.S. Environmental Protection Agency, 482N, September 1992.

Users Manual 1.06: Watershed Management Model, *Camp Dresser & McKee. For Rouge River National Wet Weather National Demonstration Project for the U.S. Environmental Protection Agency. August 1998.*